eral R & D expenditures are supporting the equivalent of 230,000 scientists and engineers for noncivilian purposes and about 84,000 scientists and engineers for civilian purposes, a ratio of about 3 to 1. In 1961, that ratio was 6 to 1, also with 230,000 scientists supported for noncivilian purposes. Could there be hope for reaching parity someday?

But, even within the federally supported civilian R & D area, we must point out that there has not been a balance of funding among all fields. Health is the largest single component here: of the $4.2-billion civilian R & D in 1970, only $2.4 billion were for nonhealth purposes. Of a $15.2-billion total, less than $2 billion of federal funds was allocated for R & D for the total of the principal remaining civilian purposes: education, housing, nonaviation transportation, urban social problems, crime control, agriculture, natural resource development, basic research via the National Science Foundation, and civilian nuclear power. Distressing as these numbers may be, it should at least be said that nonhealth, nonaviation civilian R & D has grown at an average rate of 12 percent per year since 1961.

However, with less than $2 billion per year expended for R & D in these civilian areas, most of which are not subject to the supply-demand-profit relationships of classical markets, it is not surprising that we are not receiving the shot in the arm required to couple technology for the benefit of the public/civilian sector.

National Technology Policy

But let me underscore that national technology policy is more than federal R & D allocation practices. We must encourage all segments of our society—the academic, the industrial, the governmental, and the public at large—periodically to redefine the goals toward which technology should be applied, and to reassess objectives as the environment undergoes change or as we change it.

The initial condition, then, for developing a technology policy must be a reassessment of goals. In the emergence of national goals during the past two decades, whether imposed externally by such cataclysmic events as the cold war, or sputnik, or internally more calmly, by goals commissions or deliberate private efforts, technology for social benefit has always come out at the small end of the horn. What emerges is a feeling that more intense and coherent social forces will be needed to foster the translation of technology into these areas.

Lest it be a source of confusion, we must remember the salient difference between science and technology. Science is both a means and an end. Technology is only a means. To develop a technology policy, we must identify the ends for which technology will be the means. Technology has no meaning in the abstract, only in relation to specified goals. If, as a society, we can specify these goals, technology can be applied to achieve them, appropriately guided or channeled according to the time-tested processes mentioned earlier.

To help this process operate efficiently, the technical community at large must also effect some discipline and brush away some of the old polemics: the schism between the scientist and the engineer for one. Created by some artificially imposed pecking order, this so-called distinction has tended to impose some sort of special favor on the scientist during the last quarter century. But it served no useful purpose then, and we certainly do not need it now, especially in the new social environment. We need the respective contributions of both the scientist and the engineer; they must work together under conditions that allow both to reach their most creative levels. John Gardner put it in its proper perspective when he wrote: "A society that scorns excellence in plumbing because plumbing is a humble profession and exalts mediocrity in philosophy because philosophy is thought to be a noble profession—such society is doomed to failure. Neither its pipes nor its theories will hold water."

NEWS AND COMMENT

Nuclear Safety (IV): Barriers to Communication

Amid all the other difficulties that have plagued the Atomic Energy Commission's safety research program in recent years—the upheavals in its management, the fluctuations in its budget, the long delays in getting major projects done—a number of laboratory workers have come to suspect that the AEC has tried to suppress discussion of reactor safety issues, not only before the public but within the nuclear profession as well.

Specifically, the researchers allege that on three occasions the AEC has prevented them from meeting with foreign reactor experts to talk over problems of mutual interest; that the AEC tried last fall to block a professional symposium on reactor safety scheduled by the American Nuclear Society next March; and that for years the AEC's Division of Reactor Development and Technology (RDT) sharply limited the circumstances under which even its top-level safety researchers could speak directly with the AEC's own regulatory authorities on matters pertaining to the licensing of nuclear power plants. Thus, "freedom of speech" joins the bundle of other issues raised by the years of unhappy relations between those who conduct safety research in the laboratories and those in Washington who hold the purse strings and set the course of the laboratories' work.

Allegations that the AEC had tried to limit discussion of safety issues in professional circles were made by several scientists, engineers, and research managers during a series of interviews at the National Reactor Testing Station in Idaho, the AEC installation where most of the nation's reactor safety studies are carried out. In some respects, the charges are reminiscent of those made 2 years ago by John Gofman and Arthur Tamplin, the AEC scientists

whose criticism of radiation standards made their names household words, at least in environmentally attuned households.

There are important differences between the two cases, however. For one thing, the mutual name-calling that marked the AEC's dispute with Gofman and Tamplin is absent here; the Idaho researchers seem more inclined to view officials in Washington as being misguided, rather than malicious. It is also worth noting that—with the exception of testimony presented to recent AEC hearings on emergency core cooling—safety researchers have been reticent about voicing their complaints in public, in part to preserve a semblance of working relations with Washington, and in part out of the conviction that public criticism would leave their employer, Aerojet Nuclear Company, little choice but to remove them from their jobs.

Of the researchers' three main complaints, the best documented concerns their relations with foreign experts. A dispute in this matter arose earlier this year, when groups of Japanese and German nuclear researchers and regulatory officials sought permission from the AEC to visit the Idaho installation to talk over mutual concerns about the emergency core-cooling systems of nuclear power plants. Both Japan and Germany were following an internal AEC flap over the adequacy of these backup safety systems, both countries were pressing their own research programs on core-cooling problems, and the Germans, for their part, were mulling a public recommendation from their safety advisory committee to suspend all reactor licensing until the controversy was settled.

The AEC refused to allow either technical delegation to visit Idaho, although both groups did come to the United States. The Japanese spent 2 days in Washington, D.C., in February, and an 11-man West German group, headed by director of reactor safety research Wilhelm Sahl, spent about 3 weeks talking with AEC officials in Washington and touring nuclear power plants and AEC facilities. Klaus Gottstein, the science counselor of the German embassy in Washington, said the delegation's inability to visit Idaho was not disappointing "because we knew about this decision in advance."

Why were the two groups turned away? Gottstein says he was given to understand that a visit to Idaho would be "inconvenient," as researchers there were very busy and couldn't take the time to show visitors around. The Germans were also assured that any information available in Idaho was also available in Washington. Gottstein emphasized that the meetings in Washington "went extremely well" and resulted in an informal agreement to exchange safety information more fully.* Nevertheless, several senior researchers at Idaho said they thought face-to-face talks with both the Germans and Japanese would have been fruitful and would have caused only minimal interruption of their work.

One official in the regulatory branch in Washington disagreed with the contention that the two groups had been barred from Idaho to stifle discussion of safety issues, but he was nonetheless critical of RDT officials for not allowing the visitors in. "The whole philosophy on foreign relations here is wrong," he asserted. "The thinking is that we're ahead, and so any interchange is a one-way street—we give and they take. But in issues like this we can't afford not to talk to others."

An Embattled Seminar

Another incident—this one with an apparently happier ending—raised the hackles of Idaho researchers last October. According to well-placed sources, executives of the Aerojet Nuclear Company at Idaho—acting on instructions from RDT officials in Washington—actively discouraged Aerojet scientists from planning a major national symposium on reactor safety to be held at Idaho Falls in 1973. The sources said that the scientists first were told that they could not use company time and telephones to organize the meeting. When they offered to do it all on their own time, the sources said, they were told that would not do either. "Milton Shaw [the director of RDT] just didn't want them to have that meeting, even though there had been no open meetings on safety there in years," one source asserted.

Charles Leeper, the current president of Aerojet Nuclear, indicated in an interview that Washington's objections were part of a general complaint that professional staff in the national laboratories, as well as at Idaho, were spending too much time organizing and attending meetings, with the result that productivity was less than it could be. Leeper, a physicist, commented, "I came from an [industrial] environment where 3 days a year for professional meetings is considered pretty good."

In any case, as the story goes, plans for the symposium were revived after John Landis, then president of the ANS, took the matter up with several AEC commissioners and won a compromise. The meeting will now take place this coming March, but on "neutral ground"—at the University of Utah in Salt Lake City, and with a new cosponsor—the Atomic Industrial Forum, a trade organization.

Perhaps the most serious accusation of the three voiced by safety researchers concerns the rules governing communications between the safety program, in RDT, and the AEC's separate regulatory arm, which depended on the safety program for technical help in licensing nuclear power plants.

Researchers at both Idaho and Oak Ridge National Laboratory say that as long ago as 1966, and as recently as 1971, they were expressly forbidden to speak with members of the regulatory staff about such controversial matters of reactor safety as fuel-failure and seismic research, except in meetings prearranged and closely supervised by RDT officials in Washington. During these formal meetings, the researchers said, RDT officials allowed them to answer specific questions propounded by the regulatory staff, but discouraged them from volunteering their concerns about the safety of specific nuclear power plants. Under no circumstances were they allowed to discuss "program planning" of future research with the regulatory staff or to collaborate with the regulatory staff to define technical uncertainties that might require new R & D.

The regulatory staff, of course, could always read the monthly progress reports that researchers at Idaho turned out, but the same restrictions that applied to meetings also applied to the

* There are indications, however, that the Germans came away with somewhat less than they had sought. An internal AEC memorandum, dated 8 May and initialed by the assistant director for nuclear safety, Andrew J. Pressesky, notes that the Germans are mounting a $45 million, 5-year research program on emergency core cooling problems that "should be very useful to the U.S. regulatory people and industry." However, the memo continues, when the German delegation proposed an "early exchange of raw data" and an exchange of research personnel, "the U.S. side discouraged both of these proposals and countered with the suggestion that a fuller exchange of published reports be made." The memo held out the possibility that a U.S. technical team might visit Germany later this year; during the past month, the AEC is said to have turned down a request from another group of German reactor specialists to visit the Idaho installation.

reports. Those safety researchers interviewed invariably made the additional point that these curbs prevailed all during a time when the congressional Joint Committee on Atomic Energy and the AEC's Advisory Committee on Reactor Safeguards were imploring the commission to improve communications between its "promotional" and regulatory arms.

The purpose of these restrictions, several research managers contended, was to allow RDT officials whom they considered "industry-oriented" to filter out information that might lead regulatory authorities to believe that serious uncertainties existed in reactor safety. Sources at Oak Ridge agreed that this may indeed have been one motive for screening out "speculative" information, although one research manager ascribed this procedure more to bureaucratic jealousy. "They're also out to protect their prerogatives," he said. "Mainly, I think, they didn't want us to raise questions with the regulatory people and use them to bring pressure to bear for new R & D, necessary as it might have been."

Andrew J. Pressesky, RDT's assistant director for nuclear safety, denies any knowledge of taboos on direct communications with the regulatory arm, although he says he would "prefer to be informed" of any informal conversations of this sort. "The problem," he said in an interview, "is that when an idea or a concern first arises it sometimes doesn't stand the test of time. It may not be worth anything. We want to guard against that problem."

Pressesky's denial, however, is at variance with the statements of two senior researchers who both say they were instructed in no uncertain terms "not to consult with regulatory people." (One of them says he was roundly chastised when he did so anyway). The critics readily acknowledge that RDT supported a small "technical assistance" effort within the safety program that provided about $250,000 worth of consultative services to the regulatory staff each year (out of a total water reactor safety budget of $16 million to $20 million), but they maintain that this came nowhere near satisfying the regulatory arm's need for information, especially as concerns over the adequacy of emergency cooling systems grew during 1969–71.

How did these tightly leashed communications affect the licensing of nuclear plants? Several research administrators interviewed said they thought these barriers—combined with RDT's persistent reluctance or inability to carry out research the regulatory staff wanted—deprived the AEC of information urgently needed to judge the safety of plants coming up for licensing. As one program manager expressed it:

"Whether the regulatory staff sensed this or not—some did and some did not—these difficulties placed them at an extreme disadvantage in assessing the safety needs of reactors. In fact they have been a little lax in what they let the industry get away with, because in many cases the regulatory people had no independent evaluation of what the industry was telling them."

Remedies and Secrecy

It should be clear by now that a great many problems afflict nuclear safety research in the AEC, and that these problems have been building and festering for a long time. It remains to be asked what role the five AEC commissioners played in the triangular battles between the safety program and its overlord, the RDT, and the regulatory staff. The answers, it turns out, are elusive.

Certainly there is good reason to believe that these problems have been of continuing interest to at least some of the commissioners. One can find conciliatory exhortations in occasional public speeches. But none of the commission's deliberations on this or any other subject are part of the public record. Indeed, during the years that Glenn Seaborg was chairman, from 1961–71, many of the staff once included in commission meetings were no longer invited, and the digests of commission meetings, once readily available to insiders, became scarce. In all probability the commissioners receded further than ever behind closed doors as a means of encouraging spontaneous and forthright discussions among themselves, but in the process they left few clues to their thinking.†

It is known that in 1966 the commission set up a "steering committee" of high-level staff from development and regulatory branches in an effort to bring the two sides together. Pressesky says the committee was disbanded this year because communications are now satisfactory and its services were no longer needed. Predictably though, opinions about the committee's effectiveness vary. One Oak Ridge administrator says that from his vantage point it appears the committee "never accomplished a thing."

It is also known that the commission recently considered at length, then rejected, the one remedy to current problems seemingly favored by a majority of safety program managers—that of removing the water-reactor portion of the safety program from the development side of the AEC and placing it under the wing of regulatory and licensing authorities.

This was a reasonable solution, those in the laboratories argued, because water-cooled reactors have essentially passed beyond the development stage, and what's more, such a move would liberate the regulatory staff from its reliance on the "promotional" side of the AEC for technical support. There is, moreover, a precedent for this arrangement: West Germany's safety research program is a subunit of the federal government's licensing arm.

The commission discussed the transplantation of safety research in executive (or secret) session with the Joint Committee on Atomic Energy on 25 April. The next day, in a letter subsequently made public by the Joint Committee, AEC chairman James Schlesinger said the commission had unanimously disapproved the idea. Schlesinger wrote, in part, that:

> "Safety is a fundamental element in the basic design and development of a nuclear reactor. . . . Removing the safety research function from the Division of Reactor Development and Technology would likely have detrimental effects upon the overall safety of reactors. The proposed action would create a category of safety-oriented personnel and would hinder the intimate and day-to-day exchanges that they must have with those charged with reactor design and development. Such isolation would limit their effectiveness.

In the meantime, the AEC is left with something of a mutiny on its hands among some very "safety-oriented" personnel who have, to a large degree, lost faith in the ability of officials in Washington to conduct safety research in a manner fully befitting the public welfare. The problems linger on, and there is no assurance that they will not be duplicated in the multibillion program to develop an economical fast-breeder reactor. For the very same people who helped to make the water reactor safety program what it is today are fully in charge of the breeder.—ROBERT GILLETTE

† For an analysis of the closed nature of policy formulation in atomic energy, see Harold P. Green, "Nuclear safety and the public interest" [*Nuclear News* **15** (9), 75 (1972)].